南 IMF 時のヌル・セパレータ構造とダンジェーサイクル

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The null-separator structure and the Dungey cycle in the southward IMF condition

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"The null-separator structure"

The solar wind-magnetosphere interface has a peculiar magnetic field configuration named by the null-separator structure [Watanabe et al., 2005].   In this structure, all magnetic fields in the solar wind merging with those in the magnetosphere pass the null points.   In addition, there appears the special magnetic field line connecting two null points on which the solar wind (IMF), the open and the closed magnetic field lines meet.   This field line is called the separator line [Stern, 1973].   The null-separator structure is well recognized in the global MHD simulation result for the northern IMF condition [Tanaka, 2007]. We can identify two null points in the nightside higher latitude region to the cusp in both hemispheres and two separator lines running in the dayside and in the nightside.   However, this simple null-separator structure is not conserved in the southward IMF condition [Tanaka, 2007].   Tanaka (2007) reported the structure with the cusp-null, the X-null, and the separator line in the dayside magnetopause.   This structure is different from that in the northward IMF condition.   Therefore, the null-separator structure in the southward IMF condition is still an issue to be solved.

"The Dungey cycle"

The Dungey cycle refers to the convective motion of plasmas and magnetic field lines invoked by the merging in the dayside and that in the nightside in the solar wind-magnetosphere-ionosphere system.   Namely, the magnetic field lines merging with the IMF in the dayside magnetopause are transported to the nightside magnetosphere and return to the dayside after reconnection in the nightside magnetosphere [Dungey, 1961].   This idea explains the ionospheric convection in the high-latitude ionosphere.   As the Dungey cycle is regarded to be driven by merging in the dayside magnetopause, this cycle is regarded to be closely related to the null-separator structure.   However, there are not so many studies about the Dungey cycle in terms of the null-separator structure.   For example, Fujita et al. (2015) manifested driving mechanism of the Dungey cycle only in the dayside magnetosphere.   Nobody study the three dimensional Dungey cycle in terms of the null-separator structure.   The present study is the first one dealing with the Dungey cycle in the null-separator structure in the southern IMF condition by using the global MHD simulation.

"The three-dimensional Dungey cycle in the null-separator structure"

At first, we discuss transform of the null point when the IMF turns southward from northward.   It is noted that the null points in the northward IMF condition are determined as two points in the northern and southern hemispheres.   When the front of the IMF change (northward -> southward) in the solar wind arrives at the null point, there appears an additional, new null point which is transported along with the solar wind.   The magnetic field intensity becomes very small along trace of the new null point.   Probably, this trace is a null line between the original null point and the new null point although the numerical simulation with finite grid size cannot exactly reproduce the null line.   In addition, this line is identical with the X-null found by Tanaka (2007).   This line plays an important role in the three dimensional Dungey cycle in the southward IMF condition because the nightside reconnection of the Dungey cycle appears on this "null line".   It is noted that the nightside second reconnection necessary for the Dungey cycle is apparently corresponding to the NENL [Baker et al., 1995].

References

Baker, D. N. et al. (1996), J. Geophys. Res., 101(A6), 12,975-13,010, doi:10.1029/95JA03753.

Fujita, S. (2015), submitted to JGR

Stern, D. P. (1973), J. Geophys. Res., 78(31), 7292-7305, doi:10.1029/JA078i031p07292.

Tanaka T. (2007), Space Sci Rev, DOI 10.1007/s11214-007-9168-4.

Watanabe, M. et al (2005), J. Geophys. Res., 110, A06210, doi:10.1029/2004JA010832.